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II. Solution* by **G. B. M. ZERR. A. M., Ph. D., Parsons, W. Va.**

Let $ABCD$ be the given square. Let F be a point in AB, E a point in AD, and G, H, points in DC. Let PQ be a length, measured at random in FE and FG. Let $AF=x$, $AE=y$, $PQ=z$, $DH=u$, $DG=v$, $AB=a$, $\surd(x^2+y^2)=z'$, $\surd[a^2+(u-v)^2]=z''$. $M=$the average length.

$$\therefore M=\frac{\int_0^a\int_0^a\int_0^{z'} z\,dx\,dy\,dz+\int_0^a\int_0^u\int_0^{z''} z\,du\,dv\,dz}{\int_0^a\int_0^a\int_0^{z'} dx\,dy\,dz+\int_0^a\int_0^u\int_0^{z''} du\,dv\,dz}$$

$$=\frac{\int_0^a\int_0^a (x^2+y^2)dx\,dy+\int_0^a\int_0^u [a^2+(u-v)^2]du\,dv}{2\int_0^a\int_0^a \surd(x^2+y^2)dx\,dy+2\int_0^a\int_0^u \surd[a^2+(u-v)^2du\,dv}$$

$$=\frac{\int_0^a a(3x^2+a^2)dx+\int_0^a (3a^2u+u^3)du}{3\int_0^a \left[a\surd(a^2+x^2)+x^2\log\left(\frac{a+\surd(a^2+x^2)}{x}\right)\right]dx+3\int_0^a \left[u\surd(a^2+u^2)+a^2\log\left(\frac{u+\surd(a^2+u^2)}{a}\right)\right]du}$$

$$=\frac{11a}{4[2+\surd 2+5\log(1+\surd 2)]}.$$

Also solved by J. E. Sanders.

171. Proposed by O. E. GLENN, A. M., Ph. D., Drury College.

There are n derelict steamers afloat in a circular sea of radius r. The water in the sea is moving northward in a current whose velocity varies inversely as the perpendicular distance from the north-south tangent to the sea on its west beach. Find the probability that a ship crossing the sea on a random diameter will encounter e derelicts during the voyage.

Solution by G. B. M. ZERR, A. M., Ph. D., Parsons, W. Va.

Let O be the center of the sea, POQ the random diameter, G the position of a derelict when the start is made at P, AOB the diameter perpendicular to the north-south tangent AC on the west beach A. Let FE be the chord through G perpendicular to AB, cutting AB in L and PQ in K, H the foot of the perpendicular from Q on AB. Let $\angle QOB=\theta$, $AL=z$, $GK=y$, $u=$uniform velocity of ship on PQ, $p=$chance of meeting one derelict. Then $OK=OL\sec\theta=(z-r)\sec\theta$, velocity of derelict$=m/z$.

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*The two methods illustrated are typical of the different results to be obtained when different laws of distribution are assumed.

$$\therefore \frac{r+(z-r)\sec\theta}{u}=\frac{yz}{m}. \qquad \therefore y=\frac{m}{uz}(r-r\sec\theta+z\sec\theta)=y'.$$

The limits of θ are 0 and 2π; of z, 0 and $2r$ for total, and $r(1+\cos\theta)=z'$ to $r(1-\cos\theta)=z''$ for favorable cases; of y, 0 and $2\sqrt{(2rz-z^2)}=y''$ for total, and 0 and y' for favorable cases.

$$\therefore p=\frac{\int_0^{2\pi}\int_{z''}^{z'}\int_0^{y'} d\theta\, dz\, dy}{\int_0^{2\pi}\int_0^{2r}\int_0^{y''} d\theta\, dz\, dy}=\frac{1}{2\pi^2r^2}\int_0^{2\pi}\int_{z''}^{z'}\int_0^{y'} d\theta\, dz\, dy$$

$$=\frac{m}{2\pi^2r^2u}\int_0^{2\pi}\int_{z''}^{z'}\frac{(r-r\sec\theta+z\sec\theta)d\theta\, dz}{z}$$

$$=\frac{m}{\pi^2ru}\int_0^{2\pi}(1+\sec\theta\log\tan\tfrac{1}{2}\theta-\log\tan\tfrac{1}{2}\theta)d\theta=\frac{2m}{\pi ru}.$$

Therefore the chance of meeting one derelict out of the n is $\Sigma p=2nm/\pi ru$, and the probability that e will be encountered is

$$\Pi\left(\frac{2nm}{\pi ru}\right)=\left(\frac{2nm}{\pi ru}\right)^e.$$

CALCULUS.

203. Proposed by S. A. COREY, Hiteman, Iowa.

Evaluate* $\int_0^\pi \frac{\sin mx\, dx}{x}$.

Solution by G. B. M. ZERR, A. M., Ph. D., Parsons, W. Va.

$$\int_0^\pi \frac{\sin mx}{x}dx=\int_0^\pi\left(m-\frac{m^3x^2}{3!}+\frac{m^5x^4}{5!}-\frac{m^7x^6}{7!}+\text{.........}\right)dx$$

$$=m\pi\left(1-\frac{m^2\pi^2}{3.3!}+\frac{m^4\pi^4}{5.5!}-\frac{m^6\pi^6}{7.7!}+\text{.........}\right).$$

Also solved by L. E. Newcomb.

204. Proposed by M. E. GRABER, A. M., Heidelberg University, Tiffin, Ohio.

Required the variation of $\int V dx$ where V is a function of x, y, $\frac{dy}{dx}$, $\frac{d^2y}{dx^2}$..... and v where $v=\int V'dx$ and V' is also a function of x, y, $\frac{dy}{dx}$, $\frac{d^2y}{dx^2}$.....

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*See Byerly's *Integral Calculus* (p. 23, Table of Integrals) Formulae 211 and 241. A solution not in the form of an infinite series would also be desirable.